APPARATUS FOR CHANGING SPEED OF BICYCLES

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Technical Field

The present invention relates to an apparatus for changing speed of bicycles, more particularly, as a transmission for bicycles and something using sprockets and chains, to an apparatus for changing speed of bicycles that changes speed of bicycles using inner gears inside a rear wheel hub and controlling the inner gears with controllers mounted on a hub shaft, so that the bicycle has good appearance, the manipulation of changing speed is convenient, the effect of the manipulation takes place immediately after an operation, little noises occur when changing the speed of bicycles, and the steps of speed are easily extensible.

Background Art

In general, an apparatus for changing speed (or a transmission) is installed on bicycles, and in some other cases, the transmission is installed on wheelchairs and toy cars using pedals.

As a conventional transmission for bicycles, sprockets having diverse diameters are mounted on the side of middle frame and rear wheel, and a chain which connects the front and rear sprockets. So the speed is changed by changing the coupling of the sprockets.

But the conventional transmission for bicycles has a few drawbacks in that it is too bulky because many large sprockets are mounted, moreover, noises and impacts take place when changing the speed of bicycles.

As a counterproposal to the drawbacks, there is an inner gear-type transmission that is installed in a rear wheel hub. The inner gear-type transmission is such a device that small gears and a controlling means are disposed in hub shell, so that the speed of bicycles is changed by changing the gear tooth's ratio thereof.

As an example of the inner gear-type transmission, an inner gear-type transmission hub for bicycles is disclosed by Japanese laid open patent publication

No. Hei7-10069.

The inner gear-type transmission is, as shown in FIG. 1, comprising a speed changing portion 10 which is composed of a hub shaft 6, a driving body 2, a hub 1 freely rotatable, at least two sun gears 12, 13 engaging with at least two teeth portions 11a, 11b, and a speed-change controlling portion 20 controlling the speed changing portion 10 by transforming the rotational state of a plurality of sun gears 12, 13, which is composed of a one-directional driving means 7 that is installed between the driving body 2 and the hub 1, enables the hub 1 to rotate precedently over the driving body 2, a ring-gear portion 1c fixed to the hub 1 engaging with planetary gears 11.

So the transmission can change the speed of bicycles to three states, that is, a low speed state that the driving force of the driving body 2 is transferred to the hub 1 via the one-directional driving means 7 by controlling of the speed-change controlling portion 20, and at least two high speed-states that the driving force of the driving body 2 is transferred the ring-gear portion 1c via the planetary gears 11 with speed increase.

Namely, when it is in low speed state, the driving force of the driving body 2 is transferred directly to the hub 1 by the one-directional driving means 7.

But when a rider controls the speed-change controlling portion 20, one of the sun gears 12, 13 is fixed selectively. The driving body 2 is rotating, in this state, the ring-gear portion 1c is rotating with planetary gears 11 being engaged with the selectively fixed sun gear.

In this case, the speed is controlled by the tooth's ratio among the fixed sun gear, the planetary gears 11, and ring-gear portion 1c. Because the fixed sun gear has much more teeth than the planetary gears 11, the speed of the planetary gears 11 revolving around the fixed sun gear exceeds the speed of one-directional driving means 7, therefore, the high speed state is possible.

The operation of the speed-change controlling portion 20 is, as shown in FIGs. 2A to 2C, operated by pawls 12a, 13a mounted on the side of the sun gears 12,

13, a protrusion for fixing gears 6a, and a controlling sleeve 21. That is, each step of changing speed is operated by fixing the sun gear using the pawls 12a, 13a with being fixed to the controlling sleeve 21 or by releasing the sun gears from the pawls 12a, 13a.

In a low speed state, as shown in FIG. 2A, two pawls 12a, 13a are released from the controlling sleeve 21 by the protrusion for fixing gears 6a.

But in the first high speed state, as shown in FIG. 2B, because one pawl 12a is fastening the controlling sleeve 21, one sun gear 13 is rotatable. So the larger diameter portion of the planetary gears 11 is engaging with the fixed sun gear 12.

In the other hand, when the other pawl 13a is fastening the controlling sleeve 21, the other sun gear 12 is rotatable, so the smaller diameter portion of the planetary gears 11 is engaging with the fixed sun gear 13 as shown in FIG. 2C. That is to say, it is the second high speed state.

However, in such an above speed controlling type, because two pawls 12a, 13a are installed on the opposite side to each other, there is a drawback. That is, when a rider operates a lever in order to change the speed of a bicycle, the effect of operation is delayed until one of the pawls 12a, 13a is in effect. To the most, the effect of the operation takes place after the wheel makes a half revolution.

While the above drawback could be settled a little by comprising more pawls, it is needed that the shape of the controlling sleeve 21 must be changed. But because it is also needed that the shape of the protrusion for fixing gears 6a is to be changed, it is confined to increase the number of pawls.

Even when the pawls are not in operation, friction always takes place between the pawls 12a, 13a and the controlling sleeve 21. And the friction also causes noises and abrasion, which is also a weak point.

Moreover, in case of comprising more steps of speed change by comprising more planetary gears, above drawbacks become more serious.

Disclosure of the Invention

It is an object of the present invention to provide an apparatus for changing the speed of bicycles, which changes speed of bicycles using inner gears inside a rear wheel hub and controlling the inner gears with controllers mounted on a hub shaft, so that the bicycle has good appearance, the manipulation of changing speed is convenient, the effect of the manipulation takes place immediately after an operation, little noises occur when changing the speed of bicycles, and the steps of speed are easily extensible.

According to the first aspect of the above object, there is provided an apparatus for changing speed of bicycles, the apparatus comprising: a driven sprocket receiving the driving force of a driving sprocket; a speed controlling portion which is comprising

a carrier that is fixed to one side of the driven sprocket, a plurality of planetary gears is installed; at least two sun gears that are engaging with each step of the planetary gears and ratchet-teeth is formed along inner circumference; a ring gear that is engaging with the other side of the planetary gears; an output portion, which is comprising a hub shell transferring the driving force to a rear wheel by means of the carrier and the ring gear; a clutch means that is mediating the driving force selectively with being mounted between the carrier and the hub shell, and the ring gear and the hub shell; and a speed-change controlling portion, which is comprising a hub shaft having a pawl-positioning portion; at least two set of pawls which are engaging or releasing with the ratchet-teeth of the at least two sun gears; a pawl-controlling ring that is controlling the position of the at least two set of pawls; a transforming disk having a groove along outer circumference, that a hooking portion is formed a certain position on the outer circumference, in order to transform the position of the pawl-controlling ring via a mediating portion; a spring that is for restoring position of the transforming disk to original position; a spacing portion enabling the transforming disk to rotate freely.

Brief Description of the Drawings

FIG. 1 is a partial section view showing a transmission hub for bicycles of prior art;

FIGs. 2A to 2C are schematic views of a speed-change controlling portion in each speed step of a transmission hub for bicycles of prior art;

FIG. 3 is a section view of the present invention;

FIG. 4 is a section view cut along A - A□ line of the FIG. 3;

FIG. 5 is a section view of the speed-change controlling portion of the present invention;

FIG. 6 is a perspective view of the speed-change controlling portion of the present invention;

FIG. 7 is an exploded perspective view of the speed-change controlling portion of the present invention;

FIG. 8 is a section view of the present invention according to another embodiment;

FIG. 9A is a schematic view of the speed-change controlling portion of the present invention in low speed state;

FIG. 9B is a schematic view of the speed-change controlling portion of the present invention in mid speed state;

FIG. 9C is a schematic view of the speed-change controlling portion of the present invention in high speed state;

FIG. 10 is a section view of the present invention according to the third embodiment;

FIG. 11 is a section view of the present invention according to the fourth embodiment.

Best mode for carrying out the Invention

As shown in FIGs. 3 and 4, the present invention of an apparatus for changing speed of bicycles comprises, largely, a driven sprocket 100 receiving the driving force of a driving sprocket (not shown), a speed controlling portion, an output portion, and a speed-change controlling portion.

Said speed controlling portion is comprising a carrier 210 that is fixed to one side of the driven sprocket 100 and a plurality of planetary gears 220 is installed, at least two sun gears 231, 232 that is engaging each step of the planetary gears 220 and ratchet-teeth 231a, 232a are formed along inner circumference, and a ring gear 240 that is engaging with the other side of the planetary gears 220.

And the output portion is comprising a hub shell 310 transferring the driving force to a rear wheel by means of the carrier 210 and the ring gear 240, and a clutch means 320 that is mediating the driving force selectively with being mounted between the carrier 210 and the hub shell 310, and the ring gear 240 and the hub shell 310.

The speed-change controlling portion is comprising a hub shaft 410 having a pawl-positioning portion 411, at least two set of pawls 421, 422 which are engaging or releasing with the ratchet-teeth 231a, 232a of the at least two sun gears 231, 232, a pawl-controlling ring 430 that is controlling the position of the at least two set of pawls 421, 422, a transforming disk 450 having a groove 451 along outer circumference and a hooking portion 452 is formed on a certain position along the outer circumference in order to transforming the position of the pawl-controlling ring 430 via a mediating portion 440, a spring 460 that is for restoring position of the transforming disk 450 to original position, and a spacing portion 470 enabling the transforming disk 450 to rotate freely.

In this embodiment, the clutching means 320 is comprising a clutch ring in which a group of pins is formed and a sloping portion 241 is formed on the outer surface of the carrier 210 and the ring gear 240. So the carrier 210 (or the ring gear 240) and the hub shell 310 rotate, as like a one body with being fixed by the relative displacement of the clutch ring.

But according to circumstances, a ratchet-teeth and pawls can replace the clutch ring and the sloping portion 241.

As shown in FIGs. 5 and 6, on the inner surface of the pawl-controlling ring 430, grooves are formed symmetrically with respect to the center point in order to control the position of the pawls 421, 422.

The grooves are consisted of a couple of a sloping groove 431 and a couple of an angular groove 432, and the sloping groove 431 and the angular groove 432 are formed alternatively on the inner surface of the pawl-controlling ring 430.

While the grooves are not formed as the same interval, the pawls 421, 422 are mounted in the pawl-positioning portion 411 with the same interval, so that only one set of pawls is controlled selectively and smoothly.

And the pawls 421, 422 are, as shown in FIG. 7, composed of a sag portion 421a, 422a positioning inside of the pawl-controlling ring 430 and a stopper portion 421b, 422b that is engaging or releasing with the ratchet-teeth 231a, 232a which are formed along inner circumference of the sun gear 231, 232.

The pawl 422, which is positioning relatively far from the pawl-controlling ring 430, is further comprising an extended portion 422c that is thinner than pawl body, so that it prevents the pawl 422 from engaging with other elements.

From now on, the pawl 421 denotes a first pawl that is engaging with the sun gear 231 (also, denotes a first sun gear) which is near to the pawl-controlling ring 430, and the pawl 422 denotes a second pawl that is engaging with the sun gear 232 (also, a second sun gear), for convenience.

The mediating portion 440 is comprising a splined groove 433 that is formed on one side of the pawl-controlling ring 430, a connecting portion 441 that is engaging with the splined groove 433 and a coupling groove 441 formed therein, and a pork ring 442 that is installed in the coupling groove 441 mediating the rotational force with being engaging with a splined portion 453 formed in the transforming disk 450.

Also, the spacing portion 470 is comprising a sustaining portion 471

sustaining a bearing which is mounted between the carrier 210 and the sustaining portion 471, a fixed disk 472 that is fixed to the hub shaft 410, and a plurality of spacer pin 473 that is fixed to the fixed disk 472 and contacting with the sustaining portion 471 through an arc groove 454 formed in the transforming disk 450.

And the sustaining portion 471 is rotatable and a through hole 471a is formed therein, in order not to hinder the rotation of the mediating portion 440.

FIG. 8 is showing a section view of the present invention according to another embodiment, that is, the apparatus is comprising the planetary gears 220 having three steps, three sun gears 231, 232, 233 which are engaging with each step of the planetary gears 220, and an expanded speed-change controlling portion for controlling the state of speed to four states.

That is to say, in case of comprising more than two set of pawls, a plurality of the pawl-controlling ring is installed between each set of pawls.

But other elements are the same as previous embodiment otherwise the shapes are changed.

As described above, according to the present invention, the extension of the speed step is possible, moreover, because actual controlling of speed steps takes place in the part of the pawl-controlling portion, there are little limits to increase the speed steps.

Therefore, more than four steps of speed change are also possible.

The operation and effect of the apparatus for changing speed of bicycles, having the above structure, according to the present invention are to be described as follows.

Hereinafter, speed steps, namely, low speed state, mid speed state, and high speed state will be described with reference to the first embodiment of the present invention shown by the FIGs. 3 to 7 and FIGs. 9A to 9C.

1. Low speed state

In low speed state, as shown in FIG. 9A, both the first and second pawls 421, 422 are not in the grooves 431, 432 of the pawl-controlling ring 430, that is, not engaging with the first and second sun gears 231, 232.

When the driven sprocket 100 rotates by pedaling a bicycle, the carrier 210 that is engaging with the driven sprocket 100 also rotates. Then the driving force of the carrier 210 is transferred to the hub shell 310 via the clutch means 320.

In this case, while the planetary gears 220, which is engaging with the sun gears 231, 232, rotate with the carrier 210, the planetary gears 220 are idling because the sun gears 231, 232 are in free state.

2. Mid speed state

In mid speed state, the speed-change controlling portion is disposed as shown in FIG. 9B, that is, when a rider operates a lever (not shown), the transforming disk 450 rotates a certain degree with being connected with the lever by connection means, such as a wire.

When the transforming disk 450 rotates a certain degree, the pork ring 442, which is connected in the splined portion 453 of the transforming disk 450, rotates, and the pawl-controlling ring 430 also rotates.

So the first pawl 421 locates to the sloping groove 431 and protrudes outward. As a result, the first pawl 421 is engaging the ratchet-teeth 231a of the first sun gear 231.

In this time, the second pawl 422 is protruding but not wholly, which is preferable for being sensitive to the next movement of the pawl-controlling ring 430, so that it also causes little noise.

In above described mid speed state, when the driven sprocket 100 rotates by pedaling a bicycle, the carrier 210, which is engaging with the driven sprocket 100,

also rotates. Then, the planetary gears 220 also rotates, but in this case, because the teeth portion of a large diameter (simply, a first step) of the planetary gears 220 is engaging with the fixed first sun gear 231 by the first pawl 421, the planetary gears 220 rotate faster than the carrier 210.

And the speed ratio (calculated by the number of gear teeth) of the mid speed is as follows in case that the rotational speed of the carrier 210 is unity:

$$\text{speed ratio} = 1 + \frac{\text{first step of planetary gears}}{\text{ring gear}} \times \frac{\text{first sun gear}}{\text{first step of planetary gears}}$$
$$= 1 + \frac{\text{first sun gear}}{\text{ring gear}}$$

In this embodiment, the increase of speed is about one and a half times of the low speed state.

As a result, the rotational speed of the ring gear 240 by the rotation of the planetary gears 220 exceeds the speed of the carrier 210, and the clutch means 320 makes only a faster part to transfer the rotation to the hub shell 310.

3. High speed state

In the above mid speed state, when a rider operates a lever, the transforming disk 450 rotates, as shown in FIG. 9C, that is high speed state.

When the transforming disk 450 rotates a certain degree, as the same as the mid speed state, the pork ring 442, which is connected in the splined portion 453 of the transforming disk 450, rotates, and the pawl-controlling ring 430 also rotates more.

So the first pawl 421 moves toward inner position of the pawl-positioning portion 411 of the hub shaft 410, and the second pawl 422 is located to the angular groove 432 and protruding outward. As a result, the second pawl 422 engages with the ratchet-teeth 232a of the second sun gear 232.

In above described high speed state, when the driven sprocket 100 rotates by

pedaling a bicycle, the carrier 210 that is engaging with the driven sprocket 100 also rotates. Then the planetary gears 220 also rotate, but in this case, because the teeth portion of a small diameter (simply, a second step) of the planetary gears 220 is engaging with the fixed second sun gear 232 by the second pawl 422, the planetary gears 220 rotate faster than the carrier 210, similar to the mid speed state.

And the speed ratio (calculated by the number of gear teeth) of the high speed is as follows in case that the rotational speed of the carrier 210 is unity:

$$\text{speed ratio} = 1 + \frac{\text{first step of planetary gears}}{\text{ring gear}} \times \frac{\text{second sun gear}}{\text{second step of planetary gears}}$$

In this embodiment, the increase of speed is about two times of the low speed state.

As a result, similar to the mid speed state, the rotational speed of the ring gear 240 by the rotation of the planetary gears 220 exceeds the speed of the carrier 210, and the clutch means 320 makes only a faster part to transfer the rotation to the hub shell 310.

According to the second embodiment, as described above, three sets of pawls 421, 422, 423 are provided, so higher speed states including the low, mid, and high speed state is possible.

FIG. 10 is showing a section view of the present invention according to the third embodiment. The entire construction of this embodiment is about the same as the previous embodiment.

But the direction of the installation of the planetary gears 220 is opposite to the previous embodiment. And a first pawl 321 installed in the space set by the change of the direction of the planetary gears 220 and a ring gear portion 322 formed inner circumference of the hub shell 310 are used as the clutch means (320 in FIGs. 3 and 8).

And a pin 444 fixed on the one side of the pawl-controlling ring 430 is used, and the pin 444 is connected to the transforming disk 450 through a disk 443 installed between the pawl-controlling ring 430 and the transforming disk 450. (Also, the disk 443 supports the bearing 50 as shown in FIG. 10.)

The first pawl 321 engages with the ring gear portion 322 by the operation of a spring 321a mounted on a shaft of the planetary gears 220.

Therefore, the rotational force of the driven sprocket 100 is transferred to the hub shell 310 with engagement of the first pawl 321 and the ring gear portion 322, regardless of the speed states.

FIG. 11 is showing a section view of the present invention according to the fourth embodiment. In this embodiment, the construction is similar to the third embodiment in that, the direction of the installation of the planetary gears 220 is opposite to the previous embodiment, and a second pawl 323 installed in the space set by the change of the direction of the planetary gears 220 is used as the clutch means 320.

And a ring gear 242 engaged with the planetary gears 220 and the second pawl 323 at the same time are installed outside of the second pawl 323, and a third pawl 324 is installed between the ring gear 242 and the hub shell 310.

Other elements are the same as the third embodiment.

Therefore, in low speed state, the rotational force of the driven sprocket 100 is transferred to the hub shell 310 with the engagement of the second pawl 323 and the ring gear 242 via the third pawl 324.

And in the mid speed state and the high speed state, the rotational force of the driven sprocket 100 is transferred to the hub shell 310 with the engagement of the planetary gears 220 via the ring gear 242 and the third pawl 324.

Even in the mid speed state and the high speed state, the second pawl 323 also engages the ring gear 242, but actual engagement does not take place because the rotation of the planetary gear 220 is faster than the driven sprocket 100.

Industrial Applicability

As described above, the apparatus for changing speed of bicycles of the present invention, as a transmission for bicycles and something using sprocket and chain, changes speed of bicycles using inner gears inside a rear wheel hub and controlling the inner gears with controllers mounted on a hub shaft, so that the bicycle has good appearance, the manipulation of changing speed is convenient, the effect of the manipulation takes place immediately, little noises occur when changing the speed of bicycles, and the steps of speed are easily extensible.